MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2016/2017

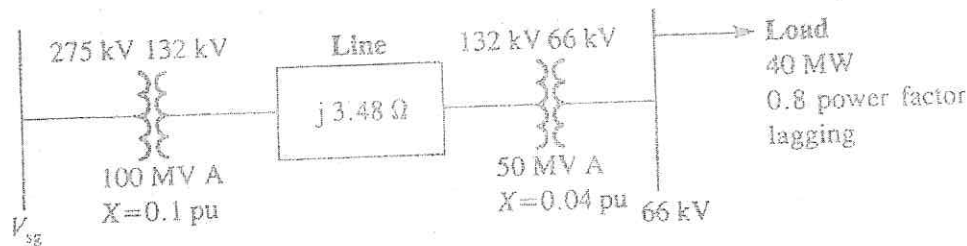### EEL3036 – POWER SYSTEMS ANALYSIS
(LE)

21 OCTOBER 2016
09.00 a.m. – 11.00 a.m.
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 4 pages including the cover page with 4 Questions only.

2. Answer **ALL** questions. The distribution of the marks for each question is given.

3. Please write all your answers in the Answer Booklet provided.

Question 1

a) State at least two out of four advantages of per-unit calculations.   [5 marks]

b) Figure Q1b represents a one-line diagram of a power system. Choose base apparent power of 100 MVA, and base voltage as the nominal transformer voltage. Calculate   [3 marks]
   i)   the per-unit reactance of the line   [2 marks]
   ii) the per-unit reactance of the transformers   [2 marks]
   iii) the base value and actual current received by the load   [2 marks]
   iv) the per-unit value of the current and voltage at the load   [2 marks]
   v)   the value of V_{sg} in per-unit and in kV   [3 marks]
   vi) draw the reactance equivalent circuit.   [3 marks]

275 kV 132 kV   Line   132 kV 66 kV   Load
                                                            40 MW
                       j 3.48 Ω   0.8 power factor
                                                            lagging
100 MV A   50 MV A
X=0.1 pu   X=0.04 pu   66 kV
V_{sg}

Fig Q1b

c) In a three-phase system, the base apparent power is 100 MVA and the base voltage is 132 kV. Calculate
   i)   the base current
   ii) the base impedance
   iii) the per-unit value of 210 A current
   iv) the per-unit value of 18 Ω impedance.   [5 marks]

Question 2

A part of a power system consists of four buses. A generator connected to BUS-1 as the slack bus, and the remaining buses are the load-bus.

   i)   draw the one-line diagram of the network, and   [3 marks]
Calculate   [5 marks]
   ii) information related to Y_{BUS} [5 marks]
   iii) present Y_{BUS} matrix
   iv) the voltages at buses 2, 3 and 4 for two iterations, by use of Gauss Siedel [12 marks]
        method.
Number of Bus : 4
Slack Bus Number : Bus-1
Number of Generator : 1
Number of Load Bus : 3
Number of Transmission Line : 4
Slack Bus Voltage : 1.0500

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All values are in per-unit:

GENERATOR BUS DATA

BUS Number	BUS NAME	Voltage	Angle
1	Slack Bus	1.0500	0.000

LOAD BUS DATA

BUS number	BUS name	PD	QD
2	Load BUS	0.2000	0.1000
3	Load BUS	0.4000	0.2000
4	Load BUS	0.2000	0.0500

LINE DATA

From	To	R	X
BUS 1	BUS 2	0.0100	0.0200
BUS 2	BUS 3	0.0100	0.0200
BUS 3	BUS 4	0.0200	0.0400
BUS 4	BUS 1	0.0125	0.0250

Question 3

a)
   i)   Define the terms: symmetrical and unsymmetricals faults.   [4 marks]
   ii) List the different types of symmetrical and unsymmetrical faults in a power system.   [4 marks]

b) State the advantages and disadvantages of the following two types of schemes used for an electric generator:
   i)   solidly grounded neutral scheme   [4 marks]
   ii) isolated neutral scheme.   [4 marks]

c) Line details of a 6-bus power system are given in Table Q3c. Calculate the bus admittance matrix by taking ground as the reference.   [9 marks]

Table Q3c

Bus connections From - to	Impedance (p.u.)
1 – 2	j0.2
2 – 3	j0.1
3 – 4	j0.2
4 – 1	j1/3
1 – 3	j0.25
2 - 4	j0.5
4 – 5	j0.1
2 – 5	j0.2
5 – 6	j0.2

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Question 4

a) What is the purpose of load flow or power flow analysis in power system?

[2 marks]

b) A 50 Hz, short transmission line system is given in Fig Q4b. The system is subjected a three-phase fault at point P. The values of generator delivering power, the terminal voltage and the infinite bus voltage are 1 p.u. The reactances of the transmission lines and of the transformer are 0.4 p.u. and 0.1 p.u. respectively, and the transient reactance of the generator is 0.2 p.u. The constant of stored kinetic energy at synchronous speed over machine rating is 4.5 MJ/MVA.

i) Show the reactance diagram and   [3 marks]

Calculate

ii) the value of terminal voltage and its angle   [5 marks]

iii) the generator current value   [2 marks]

iv) the internal voltage behind the transient reactance   [2 marks]

v) the power angle   [3 marks]

vi) the critical time in seconds   [6 marks]

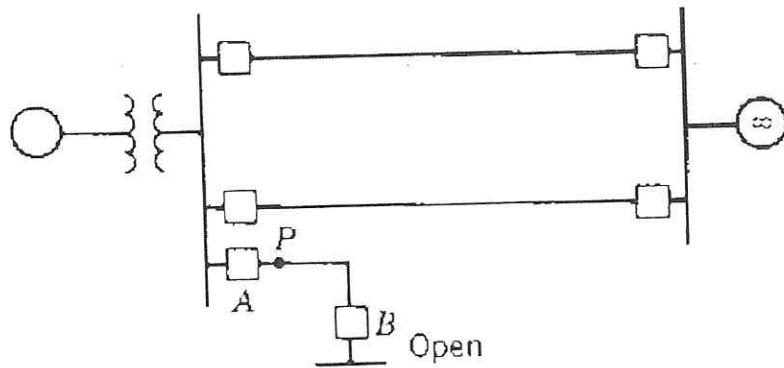vii) draw the power angle curve.   [2 marks]

Fig Q4b

You may use

$$V_i^{k+1} = \frac{1}{Y_{ii}} \left[\left(\frac{P_i + jQ_i}{V_i^k \angle \delta_i} \right)^* - \sum_{\substack{j=1 \\ j \neq i}}^{N} Y_{ij} \cdot V_j^k \right]$$

$$t_{cr} = \sqrt{\frac{4H(\delta_{cr} - \delta_0)}{\omega_s \times P_m}}$$

End of the Paper.